Physics 11 Waves and Sound review

1. A sound wave with period of 0.020 seconds is emitted from a speaker at sea level. What is the wavelength?

$v = \lambda f = \lambda/T$ so $\lambda = vT$ = 343m/s x 0.020 s = 6.9m

2. Physicists made many important contributions to the WWII war effort when Canada had the world's second largest navy. A convoy escort ship (Frigate) is hunting a submarine (U-Boat) and is using sonar to find the position. A sound pulse of 440 Hz is sent out and an echo returns in 0.030 seconds.
   a) Assuming the submarine is directly below the ship, determine the submarine's depth.

   d=vt = 1500m/s x 0.030s /2 (there and back) = 22.5m

   b) The echo returns at a frequency of 445 Hz. What does that tell you about the motion of the submarine? (bonus – give the velocity)

   Neeeyaowwww – higher frequency = moves towards the frigate

   f' = f (v+vo/v-vs) but the submarine acts as a moving source and observer
   445 = 440(1500+v)/(1500-v) v= 8.5 m/s

3. Ancient Greek amphitheatres improved sound volume by placing brass pots under the audience's seats.
   a) If we treat the brass pots as a closed pipe and are trying to maximize sound volume at a frequency of 350 Hz, how long should they be(ignore end correction)?

   $L = \lambda/4$ $v = \lambda f$ so L = v/4f = 343/4(350) = 0.245m = 24cm

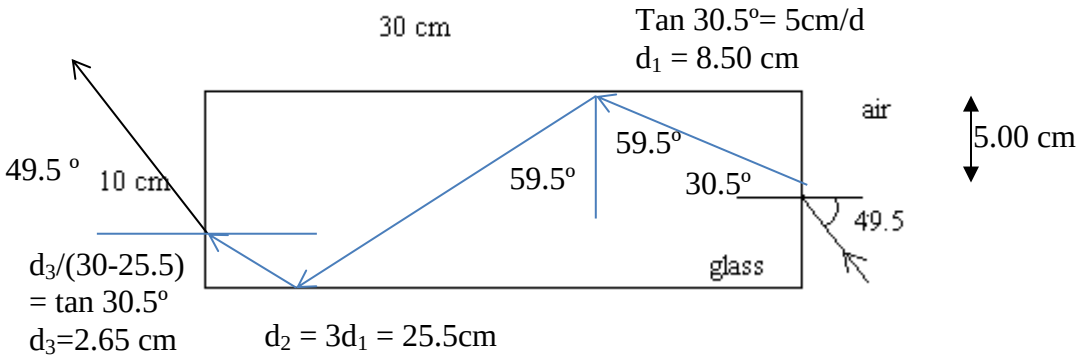
   b) How does the brass pot improve sound volume?

Sound reflects off the bottom and off the open end. If the frequency is just right, they will interfere to produce high amplitude standing waves.

4. An international amateur orchestra is assembled in Vancouver(sea level) for a charity concert. A new instrument, the Quizzaphone, is featured. It is an open pipe instrument, able to be length adjusted for tuning to a fundamental frequency of 256 Hz (middle 'C' note). All musicians tune their instruments perfectly prior to departing, however some of the Quizzaphone section are from high in the Andes Mountains. Describe what, if anything, the audience in Vancouver will experience when the Quizzaphone section plays an 'C' note and explain your reasoning. (Calculations are required for full marks)
   $L_{Andes} = \lambda/2$ $\lambda = v/f$ so L=339/2x256 =0.662m, $f_{Van} = v/\lambda = v/2L$ =(343)/2x0.662 =259Hz – 256Hz = 3Hz beat frequency is heard

Refraction Review

The following diagram shows a ray of light entering a 10.0 cm by 30.0 cm block of glass from air at a 49.5° angle half way down one side.
The index of refraction of this glass = 1.50 c = 3.00 x 10^8 m/s $n_i \sin\theta_i = n_r \sin\theta_r$ n = c/v



a) What is the speed of light in this glass block?

n=c/v v=c/n = 3.00x10^8m/s /1.50 = **2.00 x 10^8m/s**

b) What is the critical angle of this glass block?

θ_c occurs when θ_r =90º so $n_i \sin\theta_i = n_r \sin\theta_r$ 1.50sin θ_c = 1.00 sin 90º

θ_c = 41.8º

c) To what angle does the light refract when entering the block?

$n_i \sin\theta_i = n_r \sin\theta_r$ 1.00 sin 49.5º = 1.50 sin θ_r

θ_r = 30.5º

d) Draw the path of the light as it passes through, and out of, the block. (1 bonus mark if all distances are specified)

Since 59.5º is greater than the critical angle, the light reflects off the side of the block until the other end. Refer to the above diagram and calculations.

e) Why could you see a rainbow when you shine white light at the corner of the block? White light contains light of different colours. Different colours move at slightly different speed in the block, so they can separate into a rainbow.